

## CLAIMS

1. A regeneration controller for eliminating particulate matter accumulated in an exhaust purification apparatus that is arranged in an exhaust system of an internal combustion engine, the regeneration controller comprising:

a heating section for heating the exhaust purification apparatus to eliminate the particulate matter accumulated in the exhaust purification apparatus when an estimated accumulation amount is greater than a reference accumulation amount, wherein the heating section obtains the estimated accumulation amount by estimating the amount of particulate matter accumulated in the exhaust purification apparatus; and

a mode change section for changing exhaust purification apparatus heating modes when heating the purification apparatus if the estimated accumulation amount is within a mode change range.

2. The regeneration controller according to claim 1, wherein:

the exhaust system includes an air-fuel ratio;

the mode change range is set in accordance with a comparatively small estimated accumulation amount; and

the mode change section changes the heating mode when the estimated accumulation amount is within the mode change range from a normal heating mode, for heating the exhaust purification apparatus by continuously lowering the air-fuel ratio in the exhaust system, to a burn-up heating mode, for burning up the particulate matter by intermittently lowering the air-fuel ratio in the exhaust system.

3. The regeneration controller according to claim 2, further comprising:

a difference detection unit for detecting exhaust pressure difference between an upstream side and a downstream side of the exhaust purification apparatus;

wherein the mode change section determines whether to change the heating mode to the burn-up heating mode based on the exhaust pressure difference detected by the pressure detection unit.

4. The regeneration controller according to claim 2, further comprising:

a difference detection unit for detecting at least one of an exhaust pressure difference and an exhaust temperature difference between an upstream side and a downstream side of the exhaust purification apparatus, in which the exhaust purification apparatus is a downstream side one of at least two exhaust purification apparatuses arranged in the exhaust system;

wherein the mode change section determines whether to change the heating mode to the burn-up heating mode based on at least one of the exhaust pressure difference and the exhaust temperature difference detected by the pressure detection unit.

5. The regeneration controller according to claim 2, wherein the exhaust purification apparatus includes a downstream portion, the regeneration controller further comprising:

a difference detection unit for detecting exhaust temperature difference between an upstream side and a downstream side of the downstream portion the exhaust purification apparatus;

wherein the mode change section determines whether to change the heating mode to the burn-up heating mode based on the exhaust temperature difference detected by the pressure

detection unit.

6. The regeneration controller according to any one of claims 3 to 5, wherein the mode change section increases the estimated accumulation amount and continues the burn-up heating mode when the exhaust pressure difference or the exhaust temperature difference detected by the difference detection unit is greater than a mode change reference value.

7. The regeneration controller according to any one of claims 3 to 5, wherein the mode change section limits the execution of the burn-up heating to a predetermined number of times when the exhaust pressure difference or the exhaust temperature difference detected by the difference detection unit is less than a mode change reference value.

8. The regeneration controller according to any one of claims 3 to 5, wherein the mode change range includes a first mode change range and a second mode change range, which is narrower than the first mode change range, and wherein the mode change section:

increases the estimated accumulation amount and continues burn-up heating when the estimated accumulation amount is within the first mode change region and the exhaust pressure difference or the exhaust temperature difference detected by the difference detection unit is greater than the mode change reference value; and

executes the burn-up heating in a manner limited to a predetermined number of times when the estimated accumulation amount is within the second mode change region and the exhaust pressure difference or the exhaust temperature difference detected by the difference detection unit is less than a mode change reference value.

9. The regeneration controller according to claim 6 or 8, wherein the mode change section limits the number of times for increasing the estimated accumulation amount to a reference number of times or less.

10. The regeneration controller according to claim 7 or 8, wherein the mode change section:

temporarily suspends execution of the burn-up heating when executing the burn-up heating in a manner limited to the predetermined number of times; and

determines that the execution of the burn-up heating has been executed the predetermined number of times regardless of an actual number of times the burn-up heating has been performed after a predetermined period elapses from when the execution of the burn-up heating is suspended and the estimated accumulation amount becomes zero.

11. The regeneration controller according to claim 8, wherein the mode change reference value represents the exhaust pressure difference or the exhaust temperature difference that is predicted when the estimated accumulation amount is in the first mode change range.

12. A method for eliminating particulate matter accumulated in an exhaust purification apparatus arranged in an exhaust system of an internal combustion engine, the method comprising:

estimating the amount of particulate matter accumulated in the exhaust purification apparatus to obtain an estimated accumulation amount;

determining whether the estimated accumulation amount is greater than a reference accumulation amount;

adding fuel to exhaust when the estimated accumulation amount is greater than the reference accumulation amount;

determining whether the estimated accumulation amount is less than or equal to a determination value, which is less than the reference accumulation amount; and

intermittently adding fuel to the exhaust when the estimated accumulation amount is less than or equal to the determination value.